Open questions:

1. Lifetimes
   - BS lifetimes

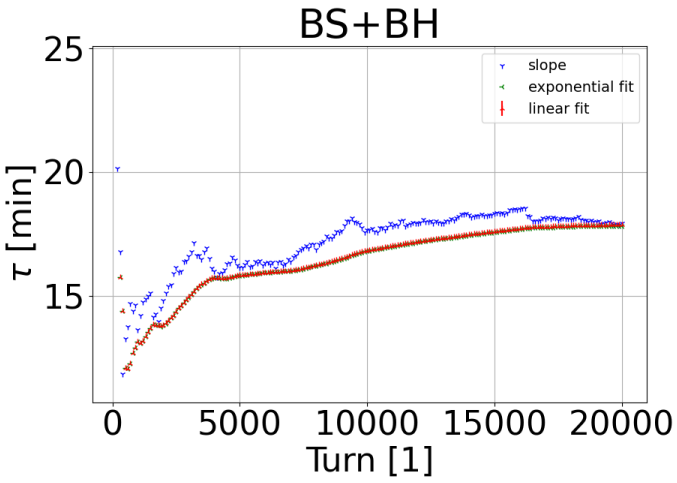
2. Crab-waist
   - 2 ways of implementing CW:
     - crab sextupoles
     - transformation at IP

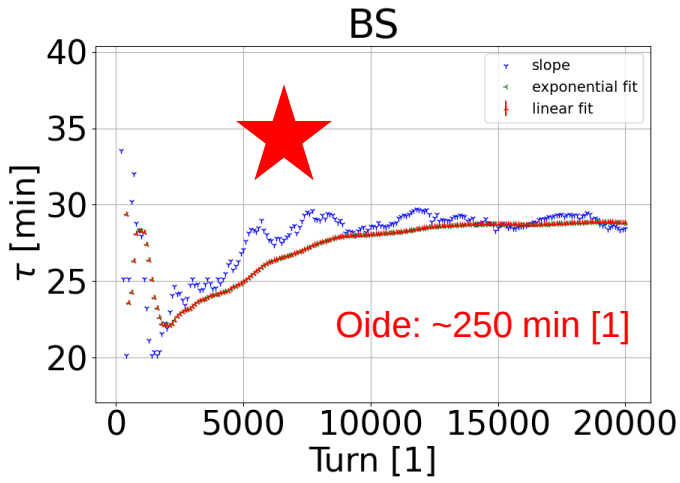
FCC Z, $\Delta\delta = 1.00$ [%]

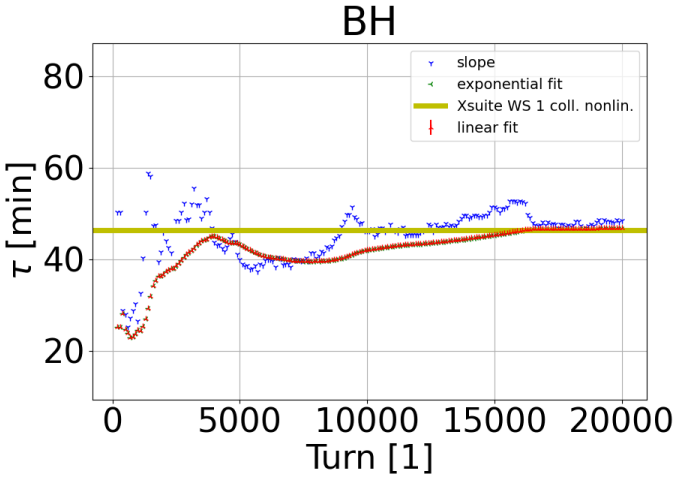
- full lattice tracking
- 1e5 mp, 2e4 turns
- taper, init, observe at middle of RF

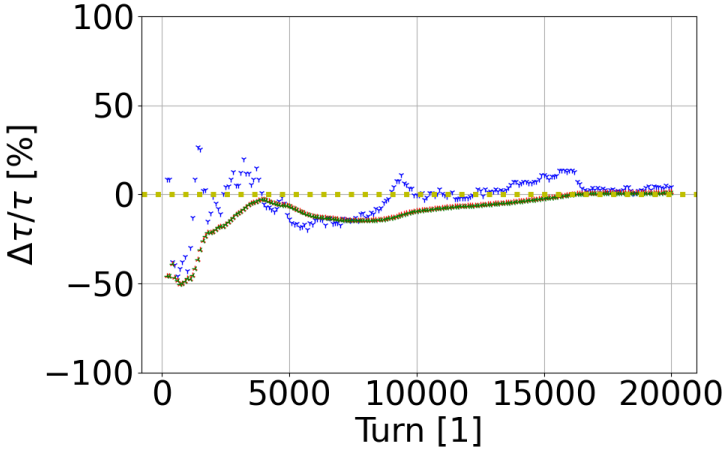
- BS lifetimes worse than those reported by K. Oide (FCC week 2023 [1], FCCIS 2023 [2])

- track until convergence with SAD?









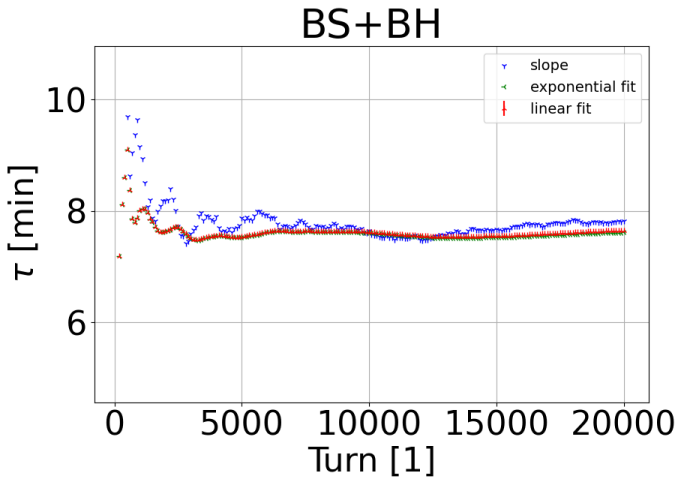
[1] https://indico.cern.ch/event/1202105/contributions/5408583/attachments/2659051/4608141/FCCWeek_Optics_Oide_230606.pdf
[2] https://indico.cern.ch/event/1326738/contributions/5650144/attachments/2750705/4787704/Optics_Oide_231113.pdf

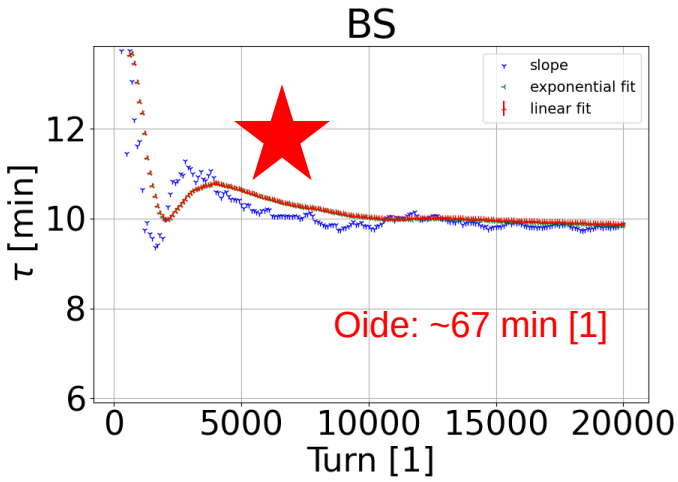
FCC W, $\Delta\delta = 1.00$ [%]

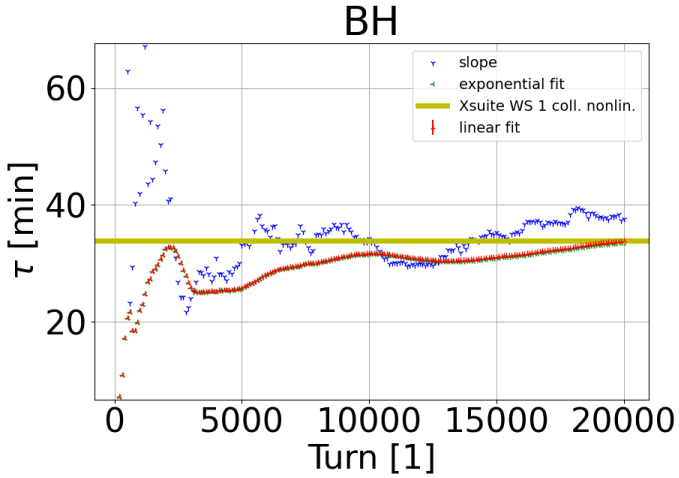
- full lattice tracking
- 1e5 mp, 2e4 turns
- taper, init, observe at middle of RF

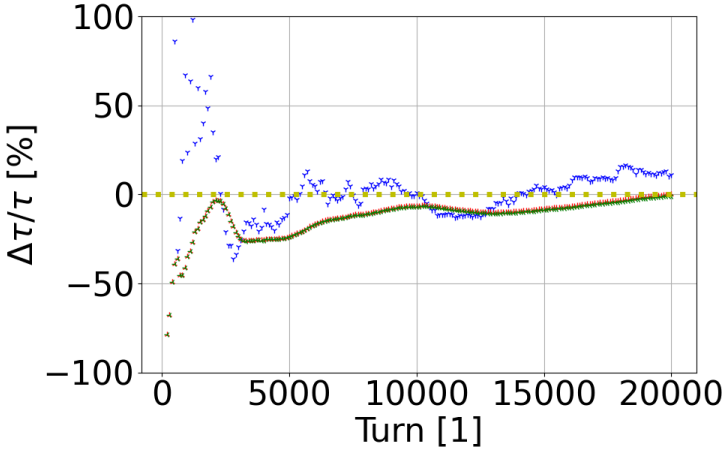
- BS lifetimes worse than those reported by K. Oide (FCC week 2023 [1], FCCIS 2023 [2])

- track until convergence with SAD?









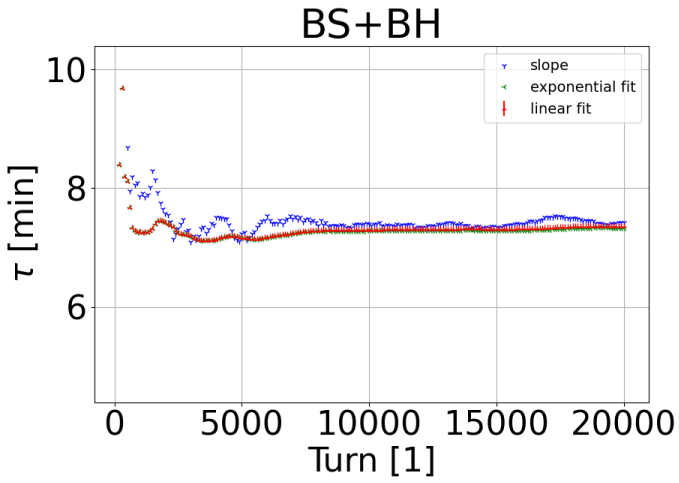
[1] https://indico.cern.ch/event/1202105/contributions/508583/attachments/2659051/4608141/FCCWeek_Optics_Oide_230606.pdf
[2] https://indico.cern.ch/event/1326738/contributions/565014/attachments/2750705/4787704/Optics_Oide_231113.pdf

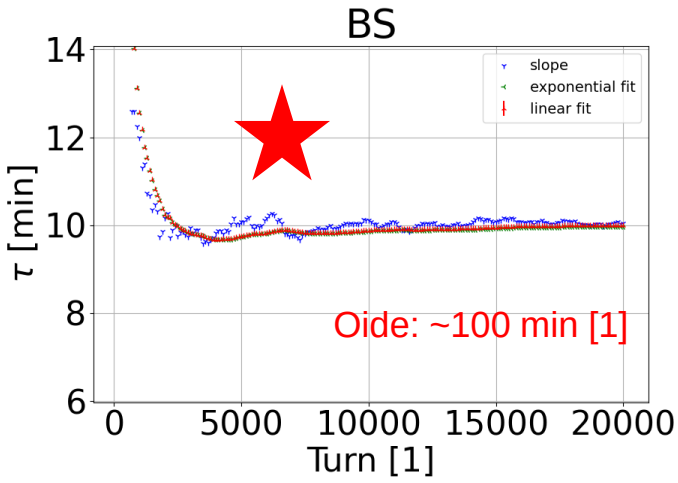
FCC H, $\Delta\delta = 1.60$ [%]

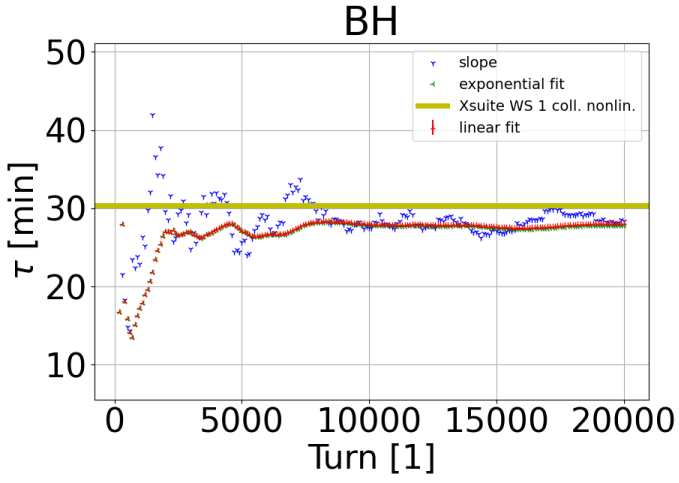
- full lattice tracking
- 1e5 mp, 2e4 turns
- taper, init, observe at middle of RF

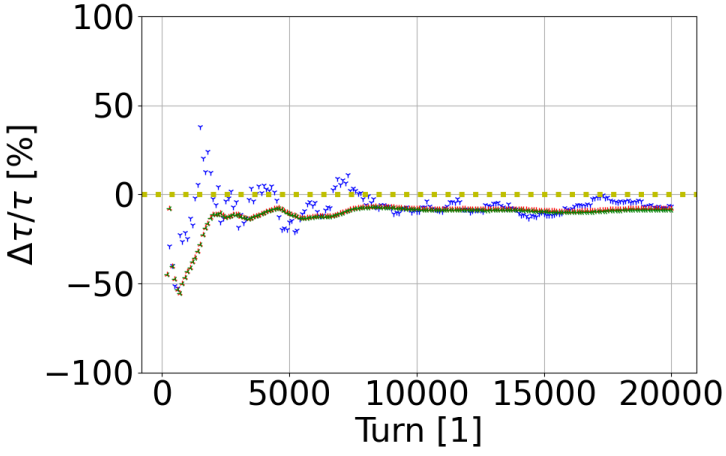
- BS lifetimes worse than those reported by K. Oide (FCC week 2023 [1], FCCIS 2023 [2])

- track until convergence with SAD?









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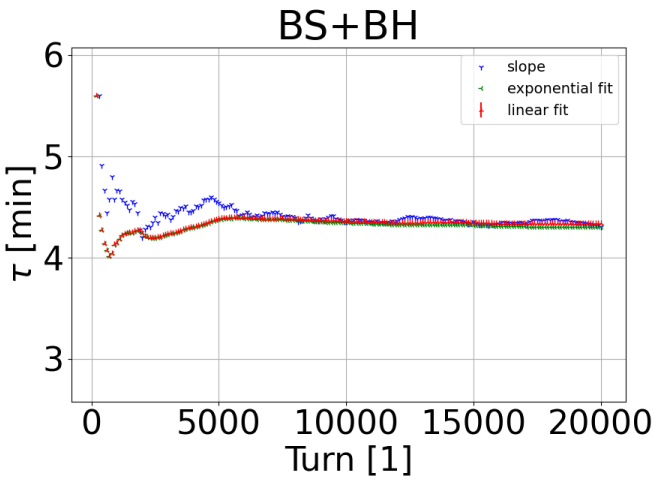
[2] https://indico.cern.ch/event/1326738/contributions/5650144/attachments/2750705/4787704/Optics_Oide_231113.pdf

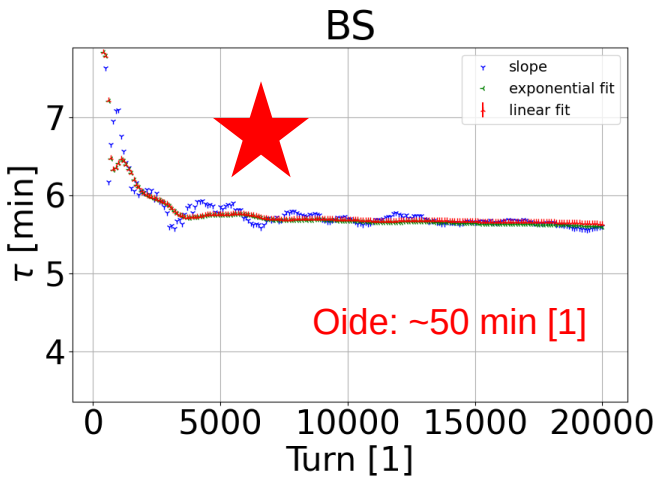
FCC T_MTR, $\Delta\delta = 2.50$ [%]

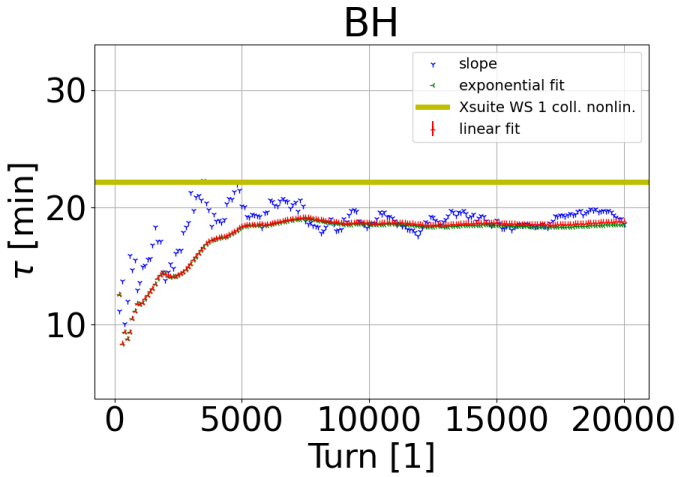
- full lattice tracking
- 1e5 mp, 2e4 turns
- taper, init, observe at middle of RF

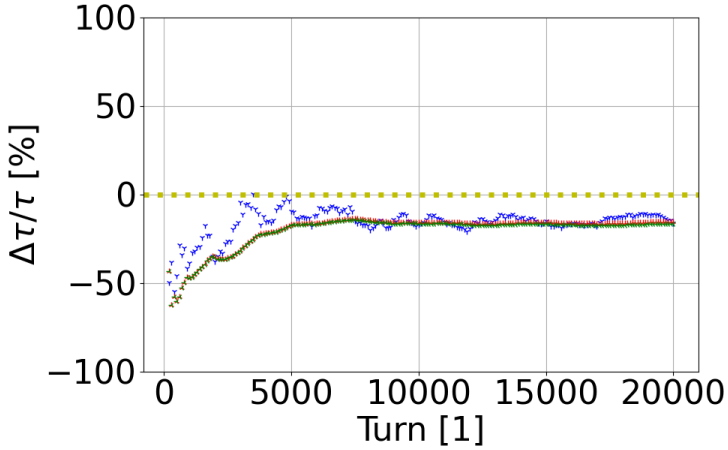
- BS lifetimes worse than those reported by K. Oide (FCC week 2023 [1], FCCIS 2023 [2])

- track until convergence with SAD?



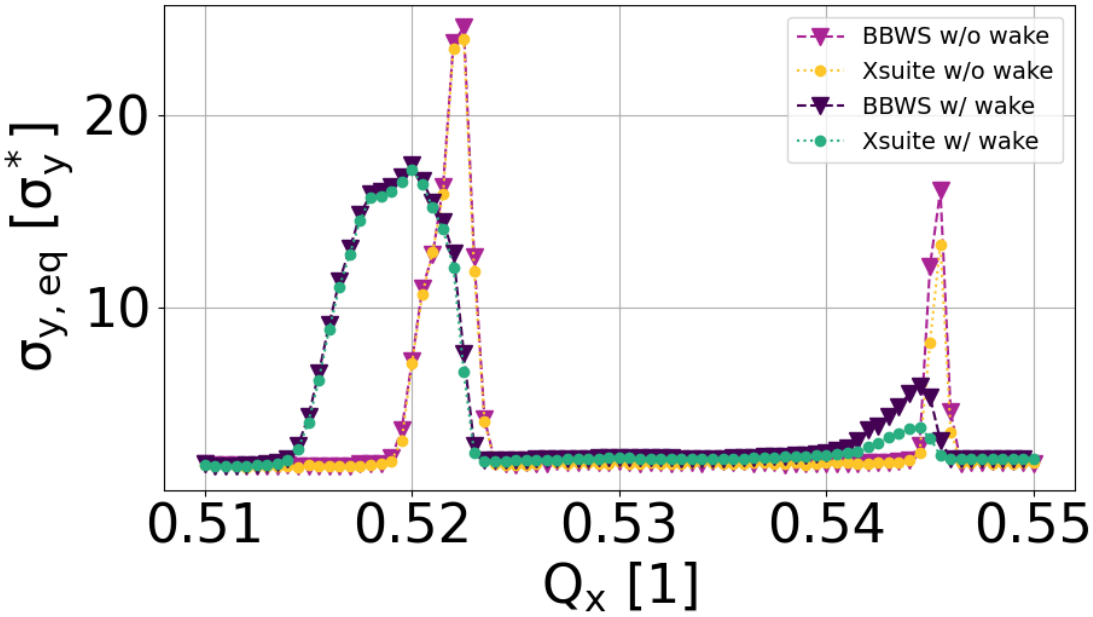






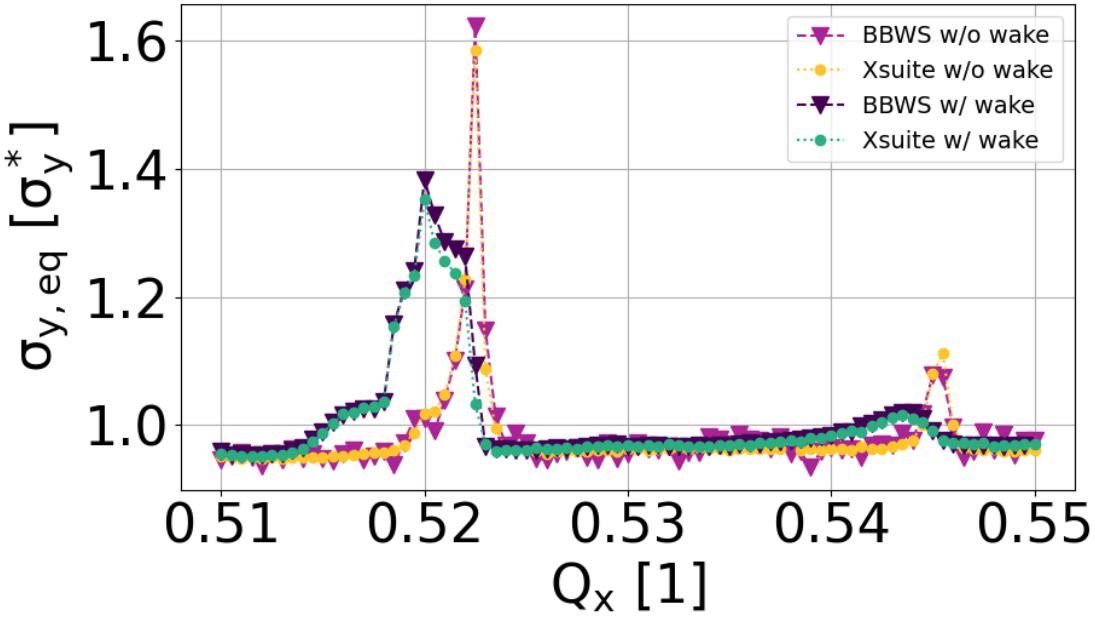
[1] https://indico.cern.ch/event/1202105/contributions/5408583/attachments/2659051/4608141/FCCWeek_Optics_Oide_230606.pdf
[2] https://indico.cern.ch/event/1326738/contributions/5650144/attachments/2750705/4787704/Optics_Oide_231113.pdf

CW OFF



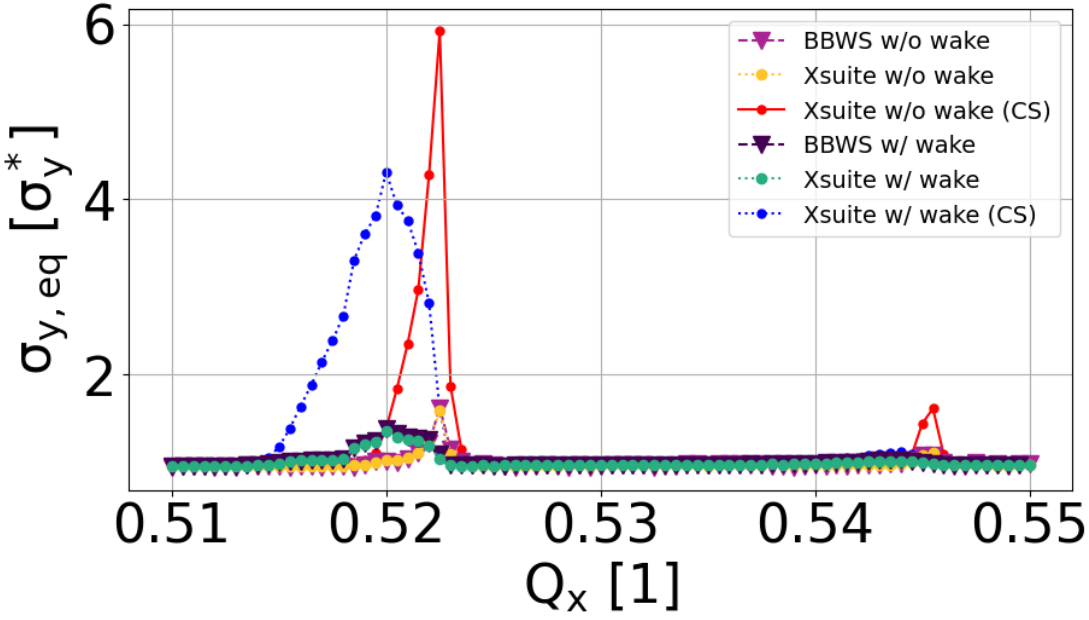
- WS, 1e5 mp, 2e4 turns
- order of elements: wakefield kick, beam-beam kick, linear arc with synchrotron radiation, observation point

CW ON



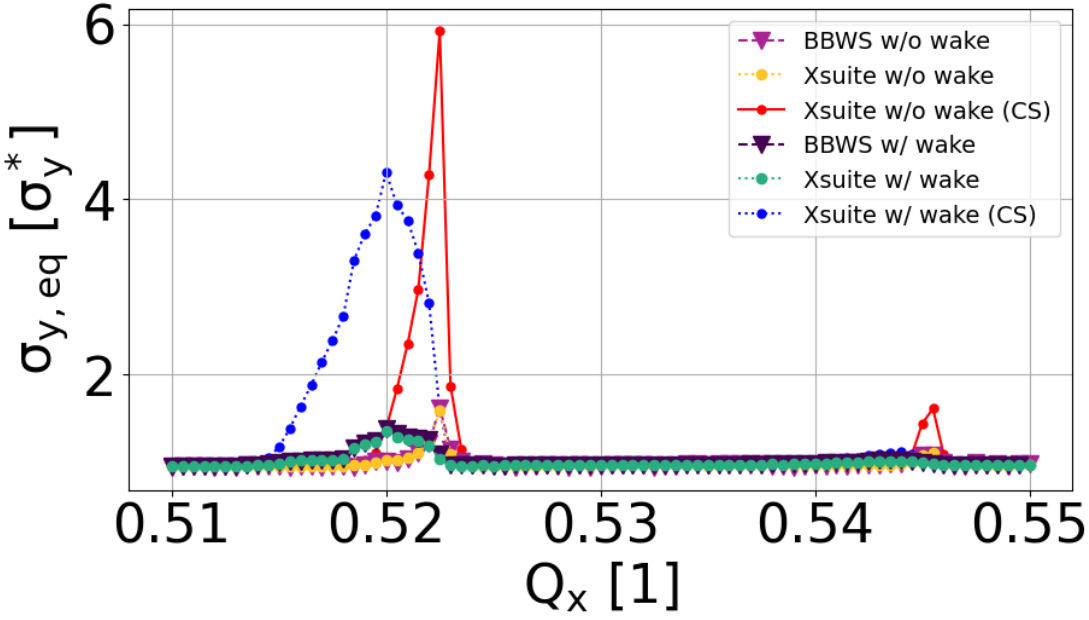
- WS, 1e5 mp, 2e4 turns
- order of elements: wakefield kick, beam-beam kick, linear arc with synchrotron radiation, observation point

CW ON



- WS, 1e5 mp, 2e4 turns
- order of elements: wakefield kick, beam-beam kick, linear arc with synchrotron radiation, observation point

CW ON

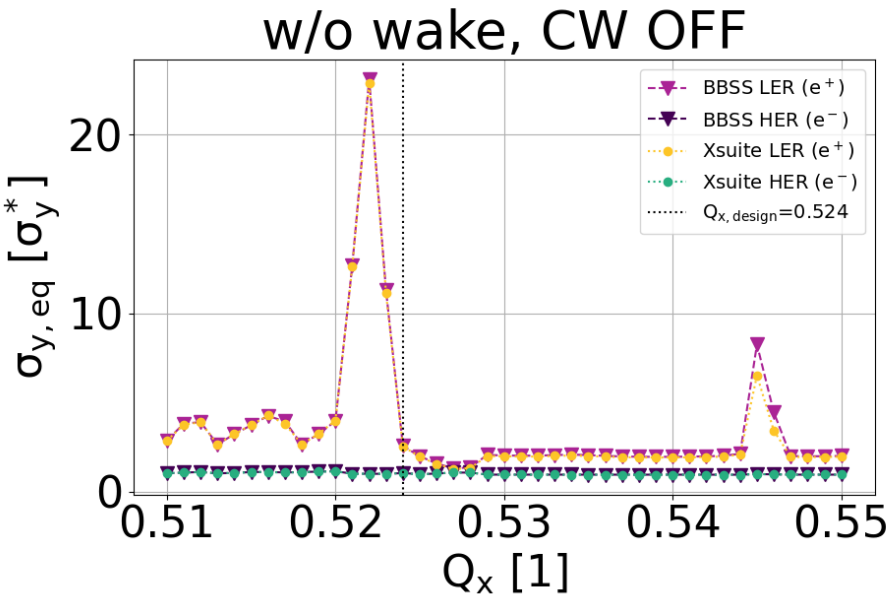


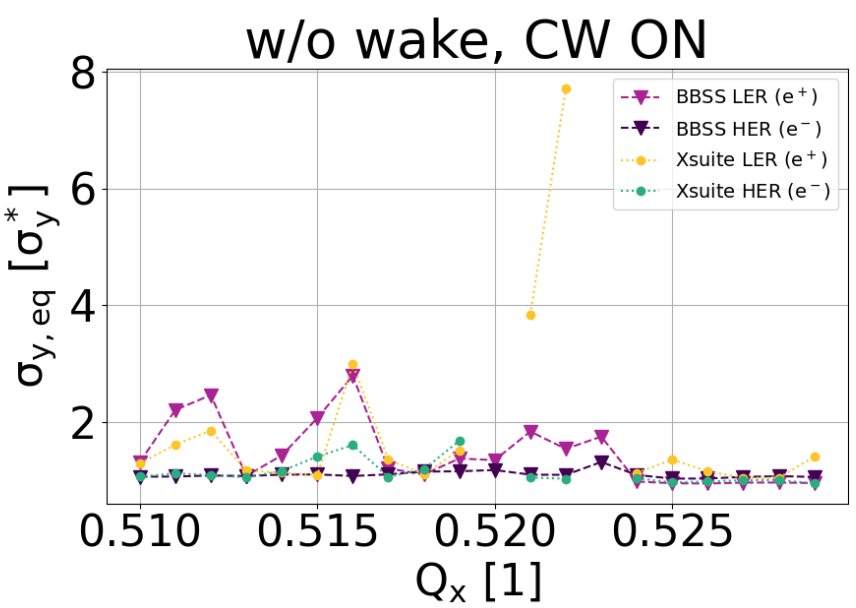
- WS, 1e5 mp, 2e4 turns
- order of elements: wakefield kick, beam-beam kick, linear arc with synchrotron radiation, observation point

- alpha at CS should not be 0:
  - drift to IP with known phase advance & betas, such that alpha at IP=0

- in progress, busy with thesis

SS model





- CW not symplectic?
- should be symplectic [3]

[3] https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.19.111005

SS model

k2_factor = x % of full strength (0 < x < 100)

```
// crabwaist
double acw;
const int flag_crabwaist = BeamBeamBiGaussian3DData_get_flag_crabwaist(el);
if (flag_crabwaist){
  double const k2_factor = BeamBeamBiGaussian3DData_get_k2_factor(el);
  double tan_2phi = 2.0*tan_phi / (1.0 - tan_phi*tan_phi);  // trig id
  acw = -k2_factor/tan_2phi;
  px += 0.5 * acw * py*py;
  y  -= acw * x*py;
}

// Change reference frame
```

- CW not symplectic?
- should be symplectic [3]

[3] https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.19.111005